Teaching Machines to Extract Main Content for Machine Reading Comprehension

Zhaohui Li¹, Yue Feng¹, Jun Xu²,³,*, Jiafeng Guo¹, Yanyan Lan¹, Xueqi Cheng¹
¹CAS Key Lab of Network Data Science and Technology
Institute of Computing Technology, Chinese Academy of Sciences
²Beijing Key Laboratory of Big Data Management and Analysis Methods
³School of Information, Renmin University of China
{lizhaohui,fengyue}@software.ict.ac.cn, junxu@ruc.edu.cn, {lanyanyan,guojiafeng,cxq}@ict.ac.cn

Abstract

Machine reading comprehension, whose goal is to find answers from the candidate passages for a given question, has attracted a lot of research efforts in recent years. One of the key challenges in machine reading comprehension is how to identify the main content from a large, redundant, and overlapping set of candidate sentences. In this paper we propose to tackle the challenge with Markov Decision Process in which the main content identification is formalized as sequential decision making and each action corresponds to selecting a sentence. Policy gradient is used to learn the model parameters. Experimental results based on MSMARCO showed that the proposed model, called MC-MDP, can select high quality main contents and significantly improved the performances of answer span prediction.

Introduction

Machine reading comprehension (MRC) aims to extract answers from a set of passages according to a question. Given a question, a large number of candidate passages could be involved. Therefore, how to identify answer-related content becomes a critical issue. Existing approaches address the issue through ranking the passages or merging the candidate answers extracted from the passages (Wang et al. 2017). However, the issue is still far from being fully addressed due to: 1) ranking of the passages is not effective for MRC because the goal is to identify the right answer from related content, rather than to find and browse the relevant passages; 2) the candidate passages could be similar in content or contain some wrong information, which makes the extracted answers overlapping or contain unrelated information.

Ideally, an MRC model shall follow the RC process of human beings. That is, human beings may first read the given question, and then go through the whole passages to identify the question-related contents, and finally conclude the answer. The attention of human beings should focus on the question-related sentences during the whole process.

In this paper, we proposed a model that could automatically identify the main content from the candidate passages through mimicking the human PC process, on the basis of the attention mechanism (Seo et al. 2016) in deep learning and the Markov Decision Process (MDP) (Puterman 2014). Specifically, given the question and the candidate passages, the attention mechanism is employed to learn the question-aware embeddings for the question and every passage sentences. After that, the MDP scans all of the sentences and selects sentences as the main content. The model, referred to as MC-MDP, is trained with end-to-end manner and policy gradient is used to update the parameters.

It is shown that MC-MDP can identify the sentences that contain the answers with high precision, and thus has the ability of boosting the performances of span prediction models. Experimental results based on MSMARCO also showed that the combinations of MC-MDP and span prediction models can improve the MRC performances in terms of F1 and Rouge-L.

Our Approach: MC-MDP

MC-MDP consists of an encoding step which employs attention mechanism to obtain question-aware representations for the question and sentences, and a MDP step for constructing the main content sequence.

Question-aware representation

Following the practices (Seo et al. 2016), two bi-directional attention models (two BiLSTMs) are respectively employed to learn the representations of the question (represented as q), and the sentences (represented as X = {x₁, ···, xₘ}) in the passages, where M is the total number of sentences in all of the passages related to the question.

Main content construction

The learned representations are used as the inputs to the following MDP model, whose goal is to construct an agent for selecting a set of sentences as the main content. The elements of the MDP is defined as:

States $S$: State at step $t$ is a triple $sₜ = [Q, Zₜ, Xₜ]$, where $Q$ is the question, $Zₜ = \{xₜ₁, \cdots, xₜₘₜ\}$ is the sequence of $t$ selected sentences, and $Xₜ$ is the set of remaining sentences. At the beginning ($t = 0$), the state is initialized as $s₀ = [Q, \emptyset, X]$, where $X$ contains the top $w$ sentences in all the candidate passages. Note the agent will scan all sentences one by one and the $w$-size window is used to control the number of actions the agent can choose from.

Actions $A$: At each time step $t$, the $A(sₜ)$ is the set of actions the agent can choose, each corresponds to a sentence in $Xₜ$. That is, action $aₜ \in A(sₜ)$ selects a sentence $xₘ(aₜ) \in Xₜ$.
The proposed MC-MDP model was tested on the public available benchmark MSMARCO, which consists of 100K questions and 1M passages. TextBlob was used to conduct the preprocessing and each word was represented as a 300-dimensional vector by GloVe. Match-LSTM (Wang and Jiang 2016) and BiDAF, two popular span prediction models, were employed to extract the final answers. As for baseline, we choose the GP (Golden Passage), which chooses passage has the largest overlap with the question as the main content. We also tested the performances of Match-LSTM and BiDAF without any main content. The evaluation metrics include ROUGE-L and BLEU-1.

MC-MDP has some parameters. The dimensions of all hidden layers were set to 150 and the dropout rate between hidden layers were set to 0.5 and the dropout rate between hidden layers were set to 150 and the dropout rate was set as 5.

In this paper we proposes to identify the main content of a question for machine reading comprehension. The model, called MC-MDP, first learn the question-aware representations for the sentences with the attention mechanism. It then selects the sentences as the main content with an MDP. Reinforcement learning algorithm was proposed to learn the model parameters in an end-to-end manner. Experiments show that MC-MDP can outperform the baselines through selecting the sentences containing the answers with high precision.

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